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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	ATTORNEY'S DOCKET NO. 11001.071
	U.S. APPLICATION NO. 09/786621

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/FI99/00767	17 September 1999	17 September 1998

TITLE OF INVENTION
Method For Sound Reproduction And Pillar Loudspeaker

APPLICANT(S) FOR DO/EO/US

Seppo Noponen, Tapani Hintsala

Applicant herewith submits to the United States Designated Elected Office (DO/EO/US) the following items and other information.

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.

2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.

3. ☐ This express request to begin national examination procedures (U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in U.S.C. 371(b) and PCT Articles 22 and 39

4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority.

5. ☒ A copy of the International Application as filed (35 U.S.C. 37(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau)
   b. ☒ has been transmitted by the International Bureau
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)

6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).

7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the Intentional Bureau).
   b. ☒ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.

8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).

10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

13. ☒ A **FIRST** preliminary amendment.
    ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.

14. ☐ A substitute specification.

15. ☐ A change of power of attorney and/or address letter.

16. ☐ Other items or information:

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE UNDER THE PATENT COOPERATION TREATY BEFORE THE UNITED STATES DESIGNATED/ELECTED OFFICES

In regard to international application:

Serial No.	PCT/FI99/00767
Applicants:	Seppo Noponen et al.
Filing Date:	September 17, 1999
Title:	Method For Sound Reproduction And Pillar Loudspeaker
Attorney Docket No.	11001.071
To:	Assistant Commissioner for Patents Washington, D.C. 20231

I hereby certify that this correspondence is being deposited with the United States Postal Service as express mail in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231 on

March 5, 2001
Date of Deposit

Christopher J. Fildes
Registered Attorney

Signature

PRELIMINARY AMENDMENT

Sir:

In connection with entry into the National Phase in the United States of the above referenced application, please amend the application as follows:

In the Specification:

P. 1, line 2, insert the heading -- Technical Field --;

P. 1, line 4, delete "according to the preamble of Claim 1" and insert -- in which a vibrating diaphragm controlled by an operating device produces sound in the air surrounding it on a first side, and in which acoustic feedback is prevented by preventing the passage of air over the edge of the diaphragm to its other side, and in which the air transports the sound to the surrounding free space --;

P. 1, line 6, insert the heading -- Background of the Invention --;

P. 3, line 7, insert the heading -- Summary of the Invention --;

P. 3, line 12, delete "The method according ... Claim 6." and insert -- A method for sound reproduction, in which a vibrating diaphragm controlled by an operating device produces sound in the air surrounding it on the first side, and in which so-called acoustic feedback is prevented by preventing the passage of the air over the edge of the diaphragm to its other side, and in which the air transports the sound to the surrounding free space, is characterized in that the diaphragm is formed as a uniformly vibrating, essentially straight and high element, so that the height H of diaphragm is at least three times, and preferably at least five times its width W, and that an essentially closed chamber is formed in front of diaphragm, except for a port arrangement, in which one or more ports essentially corresponding to the height of the diaphragm permit the passage of air and thus of sound from chamber to the free space.

The pillar loudspeaker is intended for sound reproduction indoors and outdoors. The pillar loudspeaker includes a cabinet construction supporting a diaphragm, at least one operating device for driving the diaphragm, which is operationally a straight, unified, and relatively stiff single component, which is tall vertically and narrow horizontally in such a way that the height H of diaphragmis at least three times, preferably five times greater than its width W, and in which the diaphragm is arranged to vibrate mechanically by means of the force of operating device to produce a sound in the free space. The cabinet construction is arranged to prevent acoustic feedback in such a way that the cabinet construction encloses one side of diaphragm, the other side has an air connection to the free space, and is characterized in that the loudspeaker includes a port arrangement, comprising at least one port in front of diaphragm in the construction forming chamber and

leading away from chamber, to allow air to pass from chamber to the free space. --;

P. 7, line 4, after "that" insert the heading -- Brief Description of the Drawings --;

P. 7, line 33, insert the heading -- Detailed Description of the Invention --;

P. 17, line 30, insert the paragraph -- Although the invention has been described by reference to specific embodiments, it should be understood that numerous changes may be made within the spirit and scope of the inventive concepts described. Accordingly, it is intended that the invention not be limited to the described embodiments, but that it have the full scope defined by the language of the following claims. --;

In the Claims:

Amend claims 1-15 as follows:

1. (Amended) A method for sound reproduction, in which a vibrating diaphragm [(13)] controlled by an operating device [(21, 50)] produces sound in the air surrounding it on the first side, and in which [so-called] acoustic feedback is prevented by preventing the passage of the air over the edge of the diaphragm to its other side, and in which the air transports the sound to the surrounding free space, [characterized] characterized in that the aforesaid diaphragm is formed as a uniformly vibrating, essentially straight and high element, so that the height H of diaphragm [(13)] is at least three times, [and preferably at least five times] its width W, and that an essentially closed chamber [(9)] is formed in front of diaphragm [(13)], except for a port arrangement [(5)], in which at least one [or more] port[s (27, 45)] essentially corresponding to the height of the diaphragm permits the passage of air and thus of sound from chamber [(9)] to the free space.

2. (Amended) A method according to Claim 1, [characterized] characterized in that the width d of the port [(27, 45)] is 12 - 30 % of the width W of diaphragm [(13)].

3. (Amended) A method according to Claim 1 [or 2], [characterized] characterized in that the edge [(6)] of said port [(27, 45)] opening onto the free space is rounded to a radius of 5 - 30 mm.

4. (Amended) A method according to one of Claim[s] 1 [- 3], [characterized] characterized in that said port [(27, 45)] is formed by placing diaphragm [(13)] on one, essentially flat, side of cabinet [(1)] and placing this side close to a wall surface [(28)], so that at least one said port [(27)] is formed between the edge [(6)] of the side of the cabinet [(1)] and the wall surface [(28)].

5. (Amended) A method according to [one of] Claim[s] 1 [- 3], [characterized] characterized in that said diaphragm [(13)] is permanently placed in a construction forming chamber [(9)], in the center of which is the aforesaid port [(45)] on the side opposite to diaphragm [(13)].

6. (Amended) A pillar loudspeaker intended for sound reproduction indoors and outdoors, which pillar loudspeaker includes a cabinet construction supporting a diaphragm [(13)], at least one operating device [(21, 50)] for driving the diaphragm, which is operationally a straight, unified, and relatively stiff single component, which is tall vertically and narrow horizontally in such a way that the height H of diaphragm [(13)] is at least three times, preferably five times greater than its width W, and in which the diaphragm is arranged to vibrate mechanically by means of the force of operating device [(21, 50)] to produce a sound in the free space, the cabinet construction being arranged to prevent acoustic feedback in such a way that the cabinet construction encloses one side of diaphragm [(13)] within it, the other side having an air connection to the free space, [characterized] characterized in that the loudspeaker

includes a port arrangement [(5)], comprising at least one port [(27, 45)] in front of diaphragm [(13)] in the construction forming chamber [(9)] and leading away from chamber [(9)], to allow air to pass from chamber [(9)] to the free space.

7. (Amended) A pillar loudspeaker according to Claim 6, [characterized] characterized in that diaphragm [(13)] is placed at the side of cabinet [(1)], which is arranged to be installed with attachment devices [(16)] at a distance from and facing wall surface [(28)], at least one port [(27)] being formed between an edge [(6)] of the side of cabinet [(1)] and wall surface [(28)].

8. (Amended) A pillar loudspeaker according to Claim 6, [characterized] characterized in that the cabinet construction includes an enclosure construction enclosing diaphragm [(13)], in which enclosure there is a port [(45)] on the side opposite diaphragm [(13)].

9. (Amended) A pillar loudspeaker according to [one of] Claim[s] 6 [- 8], [characterized] characterized in that the width d of said port [(27, 45)] is 12 - 30 % on the width W of said diaphragm [(13)].

10. (Amended) A pillar loudspeaker according to [one of] Claim[s] 6 [- 10], [characterized] characterized in that the loudspeaker includes several point-like operating devices [(21)] and that diaphragm [(13)] has a curved cross-section, to stiffen it.

11. (Amended) A loudspeaker according to [one of] Claim[s] 6 [- 9], [characterized] characterized in that the loudspeaker includes one or more high linear operating devices [(50)].

12. (Amended) A loudspeaker according to [one of] Claim[s] 6 [- 9], [characterized] characterized in that said diaphragm [(13)] [has] comprises a composite material, molded, or laminated construction,

its material being aluminum, kevlar, carbon-fibre, urethane, or wood fibre.

13. (Amended) A loudspeaker according to Claim 11, [characterized] characterized in that [the] a voice coil element [(55)], which moves in [the] an air port [(57)] of the body of a said linear operating device [(50)] and is elongated in its circumferential plane, is attached either directly or indirectly to the base of said diaphragm [(13)].

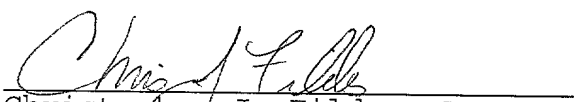
14. (Amended) A loudspeaker according to Claim 13, [characterized] characterized in that the body of said linear operating device [(50)] is a unified component, which forms two high ports between the magnetic poles, with a high voice coil [(55)] being fitted into these ports.

15. (Amended) A loudspeaker according to Claim 14, [characterized] characterized the body [(56)] of said high voice coil [(55)] is made from aluminum.

In the Abstract:

Insert the Abstract being provided on a separate sheet.

Respectfully submitted,
Seppo Noponen et al.
Fildes & Outland, P.C.



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ABSTRACT

The invention relates to a method for sound reproduction and a loudspeaker, in which a vibrating diaphragm controlled by an operating device produces sound in the air surrounding it on the first side, and in which acoustic feedback is prevented by preventing the passage of the air over the edge of the diaphragm to its other side, and in which the air transports the sound to the surrounding free space. The diaphragm is formed as a uniformly vibrating, essentially straight and high element, so that the height H of diaphragm is at least three times, and preferably at least five times its width W. Preferably, an essentially closed chamber is formed in front of diaphragm, except for a port arrangement, in which one or more ports essentially corresponding to the height of the diaphragm permit the passage of air and thus of sound from enclosure to the free space.

METHOD FOR SOUND REPRODUCTION AND PILLAR LOUDSPEAKER

The present invention relates to a method for sound reproduction and a dynamic pillar loudspeaker according to the preamble of Claim 1.

A traditional dynamic loudspeaker produces acoustic sound in such a way that an electric signal corresponding to the sound it is wished to reproduce is brought from the amplifier to the mechanisms of the loudspeaker, when, for example, a cone or diaphragm, which is connected to a magnetic voice coil acting as an operating device, moves backwards and forwards in synchronization with the signal. The movement of the diaphragm then produces an acoustic soundwave, which proceeds into the surroundings as an audible sound. The diaphragm effectively can transmit the mechanical vibratory movement of the voice coil as a movement, i.e. as a soundwave, to the surrounding air, because its surface area is large in relation to the voice coil.

Traditionally and generally, if the loudspeaker is to be capable of good sound reproduction, the loudspeaker cone or diaphragm and the components connected directly to it should be light and easily moved. This is particularly the case in the treble range, in which the sound frequencies are large and loud sounds require great acceleration of the diaphragm. On the other hand, a diaphragm creating sounds with bass frequencies should generally be large and its operating device correspondingly powerful, which in turn requires that the voice coil forming the traditional operating device is strong and has a high resistance to heat. This problem is generally solved by using a band-division filter in the construction of the loudspeaker and two or more loudspeaker elements of different sizes, each producing only sounds within its own reproduction

frequency band. These are referred to as bass (woofer), mid-range (squawker), and treble (tweeter) elements.

A traditional loudspeaker element includes a paper cone, which is thin and soft and suspended softly in the element body by means of rubber seals and spiders. Therefore, the velocities and accelerations of the cone are limited according to the forces of mass, buckling, and stiffness, which are also affected by the air pressure in, and the volume of the loudspeaker cabinet. In addition, detrimental deflection, compression, and surface waves attempt to proceed in the cone, these being discernable as distortion components in the sound produced by the loudspeaker.

The cone of a conventional loudspeaker element is a funnel, producing a horn-shaped sound lobe, so that its sound pressure depends greatly on location. As a result, the sound field is even only over a small area. If the listeners are all on the same level, but spread over a large area, the sound field must cover this entire area. The sound field can be extended by either increasing the number of loudspeakers or by directing the sound from the loudspeakers in a horizontal plane. These factors have resulted in the creation of the traditional pillar loudspeaker. In it, two or more loudspeaker elements are set sequentially vertically in the same cabinet, as disclosed, for example, in US publication 5,802,190. When they operate in phase with each other, the reinforce each other in the horizontal plane, but weaken each other in the vertical plane, so that a pillar loudspeaker produces a broad, but low sound lobe.

In public buildings, in which there are usually simultaneously both a live speaker and sound reproduction, problems arise, for example, in relation to feedback sensitivity and suitable acoustics. This is particularly the case, if music is also played in the same premises, as this demands a longer post-echo time than speech or speech reproduction. In this case, the

reproduced speech becomes more difficult to understand. In high rooms, such as churches, ceiling reflections can also cause detrimental resonances. Even in high rooms, all the listeners are usually at the same level, but spread over an extensive area, so that the energy of the loudspeakers must be directed over the same area.

The invention is intended to eliminate the defects in sound reproduction, particularly in public buildings. The intention is to create a loudspeaker, which will produce a extensive and even sound lobe, i.e. local sound field, with a sound pressure that varies only slightly as a function of location. The method according to the invention is disclosed in the accompanying Claim 1, a pillar loudspeaker according to the invention being disclosed in Claim 6. As such, a high diaphragm directed to an unrestricted space will not offer many advantages, but, if a port arrangement according to the invention is added to this, an entirely new type of loudspeaker will be created. In principle, each point on a unified loudspeaker diaphragm is an independent and dynamic source of sound. If these diaphragm points move in phase with one another, each one of them will also, in principle, send a soundwave in phase to the surrounding space. The chamber forms a pressure chamber and the port in it forms a acoustic load on the diaphragm and an effective source of sound. The sound coil of the loudspeaker compensates for the increase in the intensity of sound determined by the sum factors of the distance laws, if the listener moves closer to the loudspeaker. Correspondingly, if the listener moves farther from the loudspeaker, the sound lobe will compensate for the drop in the volume of sound, because the relative differences in distance between the different points on the loudspeaker diaphragm will diminish. The sound field of an entire auditorium can be controlled by means of the new pillar loudspeaker system. In it, each loudspeaker dominates its own vicinity, without interference from neighbouring loudspeakers, for instance. This also means that there is no need to use

delays in a system constructed with the new pillar loudspeakers, no matter whether the sound reproduction system is used indoors or outdoors.

There are several differences in principle between a pillar loudspeaker according to the invention and a traditional pillar loudspeaker, such as:

- the sound-producing diaphragm is a single and unified component, each point on which is, in principle, its own source of sound,
- the diaphragm is narrow and high, because the desired sound lobe of the loudspeaker is broad in the horizontal plane and narrow in the vertical,
- the diaphragm is controlled by a traditional or a new operating device, in which there may be one or more operating device units, such as magnetic voice coils or other units,
- the loudspeaker cabinet can be of any desired design and the loudspeakers can be made to suit the room,
- the active components of the loudspeaker are assembled in a separate module,
- there can be different loudspeaker modules for different purposes,
- the modules can be used either facing the wall or facing the listeners,
- the loudspeaker or module is preferably equipped with an acoustic load, either with or without the port arrangement referred to later,
- the acoustic load also acts as a protection, lobe director, design factor, etc.,
- the module can be installed in a recess in a wall, in which case the wall can act as an auxiliary space,
- the pillar loudspeaker can be located acoustically correctly at listener level and without disturbing the listeners,
- a reproduction system built around the pillar loudspeaker can easily be adapted,

- pillar loudspeakers will withstand being handled by an audience without being damaged,
- the acoustic energy of a pillar loudspeaker is mainly concentrated only at listener level,
- a sound reproduction system implemented using pillar loudspeakers does not require delay lines.

The most important different between a traditional pillar loudspeaker and one according to the invention is that the latter has only a single sound-producing port, which is high vertically and narrow horizontally. The height of the diaphragm is generally many times its width. Practicality will set the upper limit. It is possible to imagine a diaphragm as much as 5 m high and 50 mm wide. The diaphragm is controlled by an operating device, which usually comprises one or more magnetic voice coils or other operating device units. The operating device always controls the entire active surface of the diaphragm in phase, so that it does not create lobe folds in the sound field in the same way as a multi-element traditional loudspeaker. In the same way, there are no great discontinuities in the acoustic impedance as a function of frequency.

The second significant difference to a traditional pillar loudspeaker is that the dynamic components of the loudspeaker are assembled in a module, which can be installed in a cabinet of a desired design, which can be suspended, e.g., from a wall, or set directly into, e.g., an opening in a wall, or behind it. This method gives freedom of design, implementation, and location in sound reproduction solutions and accelerates them. An advantage in the loudspeaker module being manufactured as a separate module is that it can be quickly attached to another ready-made construction. In certain embodiments, the chamber and the port are only formed when the loudspeaker is installed in a wall. Thus, there can then be various standard products, into which the module will fit. The production process is simplified and the need to transport components is reduced.

The third significant difference to a traditional pillar loudspeaker is that a loudspeaker according to the invention is usually installed on a wall with the loudspeaker diaphragm facing the wall, in other words, the diaphragm is between the cabinet and the wall. In this case, the port between the wall and the cabinet creates an acoustic load on the loudspeaker. Usually, this port is so small, that fingers cannot penetrate it. When installed in this way, the loudspeaker will withstand being handled from the listener side, because the more fragile diaphragm is protected. The loudspeaker can be located acoustically correctly, sufficiently low down and close to the listeners, who are preferably situated in the direct sound lobe and field. When only a module is used, it can be installed directly in a recess in a wall, either with or without the aid of an acoustic load. The loudspeaker diaphragm of the new loudspeaker is a rather thin, stiff plate or moulded shape, which produces a broad-lobed sound in the horizontal plane and a narrow-lobed sound in the vertical plane. The loudspeaker is intended for the entire range of sound, but its reproduction range depends on the embodiment. The loudspeaker diaphragm will withstand normal handling, installation, and use. Modifications to the loudspeaker diaphragm will achieve desired objectives, such as evenness of the reproduction curve, variations in sensitivity, damping, protection, design requirements, etc. The loudspeaker diaphragm is suspended in a separate body unit or module, which is, in turn, installed either in a cabinet or directly in a wall. A loudspeaker with a cabinet is usually installed as a surface installation on a wall, so that the module and diaphragm face the wall. In such cases, the opposite side of the loudspeaker cabinet forms a facade facing the audience, and can be designed to suit the room in which it is wished to install it.

In the following, the construction and operation of a loudspeaker according to the invention are explained in greater detail verbally and also with reference to diagram drawings of

the loudspeaker. The following diagram and construction drawings relate to a closer examination of pillar loudspeakers equipped with different types of modules, from which it will be seen that

Figure 1a) shows a diagram of the pillar loudspeaker from in front (facade),

b) shows a diagram of the pillar loudspeaker from the rear, i.e. diaphragm side,

c) shows a cross-section of the pillar loudspeaker along its centre-line A-A,

d) shows a cross-section B-B of the loudspeaker at the operating device unit,

Figure 2a) shows an example of a loudspeaker module installed in a wall cavity with its facade plate removed,

b) shows a cross-section A-A on the centre-line of the previous installation,

c) shows one third example, in which there is an open acoustic load (port) in the centre of the loud-speaker module,

Figures 2d and 2e show cross-sections of Figures 2b and 2c,

Figure 3a) shows a cross-section A-A of the new operating device in Figure 3b

b) shows a diagram of a new loudspeaker operating device from the front,

c) shows an enlarged cross-section B-B of the new operating device in Figure 3b, and

d) shows a cross-section of a different type of magnet arrangement.

Figures 4a and 4b shows a loudspeaker installed on a post, corresponding to the examples in Figures 1a - 1d.

Figures 4c and 4d shows a loudspeaker installed on a post, corresponding to the examples in Figures 2a - 2b.

Figure 1a shows the facade of a wall-installed pillar loud-speaker, the cabinet 1 of which, designed as desired, is made of MDF-board, or some other suitable material. The material of

the cabinet should be stiff enough to ensure that its natural resonances do not interfere with the sound reproduction of the loudspeaker. Machining or moulding technology can be used to construct the cabinet. The facade 2 of the cabinet can have aesthetic details and constructions 4, while its shapes can be designed as desired. The width and depth of the cabinet will affect the shape of the sound lobe, while the volume of the cabinet will mainly affect low-frequency reproduction sensitivity.

Figure 1b shows the same loudspeaker from the rear. Compacted module 10 is installed in the cabinet opening 8, the module being standard and in the desired cabinet, designed for the aesthetic requirements of the reproduction room. There can also be various types of standard module, to meet, for example, different output, sound reproduction, and spatial requirements. Installed inside the body 11 of the module are the active and other components relating to sound reproduction, such as loudspeaker diaphragm 13 installed with the aid of diaphragm seals 14 and end pieces 15, wall attachments 16 for suspending the loudspeaker, socket 12 for connecting the amplifier, and an operating device, which is installed in body 11 inside cabinet 1, and which converts the electrical energy of the amplifier to mechanical vibratory movement in the diaphragm 13. The height 13a of module 10 and the moving part of its diaphragm 13 determine the directivity of the vertical place of the sound lobe. As the location of module 10 can be altered mainly vertically in relation to cabinet 1, the location of the source of sound can vary, even though the loudspeaker, which for example is attached to a wall, is not moved.

The flexible suspension of loudspeaker diaphragm 13 permits sufficient movement in the diaphragm for the desired sound pressure. Instead of end piece 15 of diaphragm 13, it is also possible to use some other sealing piece that acts linearly. This will keep diaphragm 13 oriented in relation to the

operating device while permitting movement in the diaphragm. Various types of joint, hinge, or bending component can also be used to help to suspend and direct the diaphragm. The end of diaphragm 13 may also incorporate a structurally flexible zone, which replaces the separate piece 15. This can be made by, for example, reducing the thickness of the diaphragm in the vicinity of its end. Connector piece 15 also permits a slight longitudinal movement in diaphragm 13, assisting the movement of the diaphragm and thus sound production.

The loudspeaker diaphragm 13 may be curved, flat, concave, or shaped and sufficiently stiff so that it will withstand even powerful bass sounds. The external appearance of the diaphragm is almost a rectangle, the height of which is at least three times that of its width. In special embodiments, the diaphragm can even be several metres high. In principle, diaphragm 13 comprises one or two narrow channel strips, which is glued or moulded to material between to form a stiff layered structure. The surface material can be aluminium, carbon fibre, kevlar, or other suitable material, the material between being balsa, foam plastic, felt, etc. Diaphragm 13 is finished as desired, for example, by painting, surfacing with rubber, etc.

Loudspeaker diaphragm 13 should move sufficiently over a surface area corresponding to the desired frequencies, producing the desired sound pressures in a certain lobe and state of reproduction. The machining, component gluing, laminations, and mouldings, as well as surfacings, required by sound reproduction can be carried out on diaphragm 13, either during the construction of the diaphragm, or later. These can include grooving, perforations, infilling, thinning, recessing, or stiffenings that limit and damp deflection, such as structural components and shapes that are left raised. In addition, the flexibility and constructional technique of diaphragm 13 can be altered as required by the sound reproduction properties, according to the voice coil distance or the active principle of

motion of the diaphragm. In some embodiments, it may be necessary to use certain additional constructions, such as separate dampening materials or structures in the cabinet, to improve the efficiency, sensitivity, output resistance, or other properties of the loudspeaker. In addition, diaphragm 13 is constructed in such a way that it moves in its entirety at low reproduction frequencies, but when the reproduction frequency increases, the vibrating area of the diaphragm diminishes correspondingly, until at the upper treble frequencies the only areas that vibrate are those to which the motion of the voice coil is directly connected.

Figure 1c shows a cross-section on centre-line A - A of pillar loudspeaker 1, in which the loudspeaker is suspended from wall 28 by means of wall attachments 16. The special feature in this case is that loudspeaker diaphragm 13 is set in the cabinet to face the wall, and not to face the listeners, as is usually the case. This arrangement particularly intended for the sound reproduction requirements of public rooms, where a sufficiently broad and even sound field can be created in an auditorium by means of several similar pillar loudspeakers. Loudspeaker cabinet 1 is set at a suitable distance from the wall, so that loudspeaker diaphragm 13 cannot be touched while installation wall 28 forms a suitable acoustic load for loudspeaker diaphragm 13. This affects the tuning of the loudspeaker, the reproduction area, and the lobe properties. Loudspeaker diaphragm 13 is relatively close to the wall, but, even at the greatest diaphragm amplitude, diaphragm 13 does not touch wall 28. The loudspeaker lead from the amplifier enters the loudspeaker through socket 12, which is either surface-mounted or sunk. The figure shows the internal volume 26 of the loudspeaker, which has a central effect on the lower boundary frequency of the loudspeaker.

The cabinet filling is usually mineral wool and also absorbs the acoustic reflections of the cabinet. The vertical height

13a of the moving loudspeaker diaphragm 13 determines the range of the sound lobe in the horizontal plane, which must be taken into account as the sound field requirement of the loudspeaker. In practice, this vertical height is slightly greater than the length of operating device 20, due to structural and inertia factors in the diaphragm. The same factors increase the active surface area of diaphragm 13 when reducing the frequency, even though the diaphragm of the pillar loudspeaker is narrow. It must be noted, that in embodiments in public rooms intended for the reproduction of speech, when the person speaking and the loudspeakers are in the same room, a pillar loudspeaker need not produce frequencies of less than 100 Hz, as this might otherwise reduce the comprehensibility of the reproduced speech.

The properties of operating device 20 are determined by the type, output, directivity, or carrying power of the loudspeaker. It will be seen from Figure 1c that operating device 20 comprises, for example, three conventional voice coils 21 or other operating device units. The mutual electrical connections of the voice coils can also be switched between series and parallel connections, according to the frequency range, impedance, sensitivity, and lobe requirements. If there are several conventional voice coils 24 in the operating device, each of them is connected mechanically from a small area to the centre-line of diaphragm 13. In this case, if the frequency and intensity increase sufficiently, push-pull areas may be created in the diaphragm, both permitting detrimental drops in the sound pressure of the loudspeaker at the frequencies in question and there are the appearance of phase errors or lobe folds in the sound lobe, in the treble range.

Figure 1d shows an enlarged cross-section B - B of pillar loudspeaker 1 at magnetic voice coil 24, when the loudspeaker is suspended from wall 28 by means of suspension piece 16. Though in this case the surface of cabinet 1 is set parallel to

the surface of the wall, the adaptation of the suspension devices will permit its be installation at an angle to the wall, leaving a port only at one edge, with the other edge closed.

Magnetic voice coil 24 is one part of operating device 21, which moves diaphragm 13. Voice coil 24 is connected to the diaphragm either directly or else by means of an intermediate component, i.e. a diaphragm seat. Magnet 23 is suspended in module body 11 by means of a magnet bridge 25, which also centres the port of magnet 23 of voice coil 24. Diaphragm 13 is suspended in module body 11 from its edges by means of flexible seals 14. An enclosure 9 is formed between the wall surface 28 and cabinet 1 at diaphragm 13, from which the sound lobe discharges to the environment from the ports 27 between the loudspeaker and the wall surface. These ports 27 form an important port system 5 from the point of view of the operation of the loudspeaker. If an asymmetrical sound lobe is desired, the sound lobe can be oriented by blocking one of the ports 27 in a controlled manner, in which case the sound will only be discharged through the other port, as in an angled installation. Thus, the sound lobe can be directed, even after the installation of the loudspeakers. The direction is also influenced by factors such as the bevelling (radius 5 - 30 mm) of the rear edges 6 of the sides of the cabinet, which also affect the local lobe diffractions in the upper treble range. Because a loudspeaker diaphragm 13 installed in this way is in a small space between the side ports 27, diaphragm 13 is connected to the surroundings by means of a short transfer line. The air velocity in it increases, especially at low frequencies, due to the effect of the diaphragm movement. Chamber 9 and port 27 create a slight horn effect. The width d of port 27 is 12 - 30 %, preferably about 20 %, of the width W of diaphragm 13. The greatest depth of the chamber is of the same order.

Generally, spiders are not needed to centre the magnet of the voice coil, because the diaphragm is stiff. Normally, the voice coil is glued to the diaphragm's 13 recess or seat 37, in which there are also leads from the amplifier socket 12 of body 11. There may also be a movement limiter in diaphragm 13, which prevents excessive amplitudes of movement in the diaphragm. On the other hand, even the seal and suspension construction may act as a sufficient limiter. If, for example, a spider construction is used in a large output loudspeaker, it can be assembled from lever-like or joint components, which not only perform the aforementioned centring and connections, but also prevent the lateral vibration of the voice coil.

In principle, diaphragm 13 is a linear source of sound. For example, it is stiffened in such a way that a filler material between two curved and hard surfaces separates the surfaces from each other. The filler material can be, e.g., paper, balsa, urethane, styrox, or a composite material. The support construction of diaphragm 13 can be of a desired shape. The thickness, mass, and other details of the construction of diaphragm 13 are determined by the desired reproduction characteristics. Between module body 11 and diaphragm 13, there may also be a damper, e.g., cloth, wool, cotton-wool sheet, cellular rubber, foam plastic, which acts as a tuning element against the diaphragm to damp its vibrations.

Diaphragm 13 is preferably a composite, moulded, or laminated construction, made of aluminium, kevlar, carbon-fibre, urethane, or wood fibre.

Figure 2a shows an embodiment of a loudspeaker according to the invention, in which the 'design' cabinet is replaced by, e.g., a wall as the place of installation of the loudspeaker module 10. Module 10 is sealed into, e.g., wall opening 40 or behind it, with diaphragm 13 outwards, so that the loudspeaker construction is closed. The volume of the loudspeaker then

becomes part of the wall, because the diaphragm port in module body 11 permits a flow of air behind diaphragm 13 into the wall structure, in which case, e.g., the low-frequency sensitivity increases. In such a case, the acoustic load to be set in front of diaphragm 13, i.e. the protector and facade board 42, also acts as a lobe director and, along with the diaphragm dimensions and the amplitude of movement, affects the sound reproduction characteristics of the loudspeaker.

Figure 2b shows a cross-section along the centre-line of a module installed in the above wall opening 40. In the backing space, i.e. in wall construction 47, there are generally damping materials, which affect the sound reproduction characteristics of the loudspeaker. In the figure, the module is installed in front, on top of the opening in the wall board. Figure 2d shows a cross-section of the installation. The figure does not show the bevelling of the edges of port 27, which are only of significance at high frequencies.

Module 10 can also be sunk into the opening. If the installation has been carried out behind the board, for example, when the boarding has been installed, the acoustic load can be at the level of the wall board, so that the loudspeaker can hardly be distinguished from the wall. This is particularly the case, if the acoustic load is a board with a port, as shown in Figure 2c, for instance, sturdy anodized aluminium strip. Figure 2c shows a preferred embodiment of loudspeaker 1. In Figure 2c, there is a desired acoustic design load, which is in the wall opening on top of the loudspeaker module. In front of loudspeaker diaphragm 13 is a narrow port 45, i.e. a board piece equipped with an acoustic load opening 45, a facade board 42, which can also be its installation board, panel, etc. Together with diaphragm 13 and the module seal, this forms a nearly closed space (except for port 45). Body 11 is closed, so that the operation of the loudspeaker is the same as in the previous case. As a result of load 42, the acoustic impedance of

diaphragm 13 increases, when diaphragm 13 is dynamically pressurized. Thus, when the loudspeaker operates, air flows from its port 45, particularly at low frequencies depending on the volume, when the velocity of the air increases and the efficiency of the loudspeaker also increases. This creates an advantage, in that a small loudspeaker construction can produce powerful low reproduction frequencies. In addition, the loudspeaker directs the sound, according on its dimensions. The construction of the pillar loudspeaker may include other acoustic elements and guides, which affect the frequency reproduction and tuning.

Figure 2e shows a cross-section of example 2c. The entire construction can also easily be imagined as being in an independent cabinet, either standing on the floor or hanging from the ceiling.

In Figures 4a and 4b, the pillar loudspeaker is installed on a pole. The independent cabinet 10 forms a port 27 with the side of the pole. Correspondingly, in Figures 4c and 4d, the pillar loudspeaker is installed inside the pole. Facade board 42 forms a port 27 with the side of the pole 16.

Figure 3a shows a cross-section A - A of the new operating device of pillar loudspeaker 1, i.e. of linear operating device 50, which is long and thus suitable for controlling the diaphragm 13 of a loudspeaker according to the invention. It does not create push-pull phase areas in diaphragm 13 even at treble frequencies, because it operates in phase over its entire length. The linear operating device 50 is entirely connected to diaphragm 13, so that it is evenly loaded. The construction of operating device 50 is due to the long and narrow magnet connecting strap 54, and the corresponding magnet arrangement 52, which preferably comprises several neodym magnets 53. Because these magnets are small in relation to their energy content, slim and even small loudspeakers can be

constructed with the aid of an operating device according to the invention.

Figure 3b shows linear operating device 50 seen from in front. It shows magnet body 52, magnet connecting strap 54, on either side of which are glued suitable neodym magnets 53. The voice coil 55 is set around magnet connecting strap 54 in port 57 and is centred so that it does not make contact with the magnet arrangement.

Figure 3c shows cross-section B - B of the linear operating device. The voice coil comprises an aluminium body 55 and a copper coil 56 glued to it. The aluminium body is made from extruded section or by edging sheet aluminium. Thus it has a large thermal capacity, so that the construction is also well suited to high-power loudspeakers. Figure 3d shows an example of a linear operating device with a voice coil 64 that is even smaller than the previous one. It has two neodym magnets 63, so that the construction does not have a separate connecting strap.

The following points can be made in connection with the linear operating device:

- Vortices arise in the port of a moving conducting metal magnet, and tend to resist the movement of the voice coil when it is producing sound (especially when it is connected to the diaphragm).
- There are several good and appropriate materials for making the body of the voice coil, such as capton, aluminium, traditional pressboard, cardboard or paper, and suitable plastics.
- Vortices can be prevented by the following means:
  - the body of the voice coil can be made from non-conducting materials, such as capton, ceramics, plastics, composite materials, carbon-fibre (with the fibre arranged to be non-conducting), kevlar, etc..

- if the body is made from a conducting material, e.g., aluminium, it can be made thin, in which case the effect of the vortex diminishes, or by making saw or file cuts in the body, which prevent the current circuits of the electromotor forces arising at the air port in the body from closing outside the air port.
- if the body is made from a conducting material, such as aluminium (a good thermal conductor), in addition to the above, the body can be constructed using a laminating technique, so that long flow loops do not arise.
- the body of the voice coil can be ended before the air port, so that the voice coil that is actually in the air port is glued (e.g., with ceramic material) to the body, so that the potentials referred to do not arise.

The invention is not limited to the embodiments disclosed above, as these can be varied within the scope defined by the Claims. Thus, for example, diaphragm 13 need not be flat, but can include other shapes or be part of the rest of the construction. The flexible edge permits even the large amplitudes of movement in the diaphragm, which are required when producing low and powerful bass sounds. Nonetheless, even the flexible edge can be of the same material or component as diaphragm 13. Thus, the flexible edge can be constructed either in the diaphragm material or can be a separate component of a different material. The diaphragm material can be preferably selected from many appropriate and durable materials, such as fibreboard, woven materials, plastics, composite materials, and even metals.

AMENDED CLAIMS

[received by the International Bureau on 09 February 2000 (09.02.00); original claim 6 cancelled; claims 1-16 renumbered as claims 1-15 (3 pages)]

1. A method for sound reproduction, in which a vibrating diaphragm (13) controlled by an operating device (21, 50) produces sound in the air surrounding it on the first side, and in which so-called acoustic feedback is prevented by preventing the passage of the air over the edge of the diaphragm to its other side, and in which the air transports the sound to the surrounding free space, characterized in that the aforesaid diaphragm is formed as a uniformly vibrating, essentially straight and high element, so that the height H of diaphragm (13) is at least three times, and preferably at least five times its width W, and that an essentially closed chamber (9) is formed in front of diaphragm (13), except for a port arrangement (5), in which one or more ports (27, 45) essentially corresponding to the height of the diaphragm permit the passage of air and thus of sound from chamber (9) to the free space.

2. A method according to Claim 1, characterized in that the width d of the port (27, 45) is 12 - 30 % of the width W of diaphragm (13).

3. A method according to Claim 1 or 2, characterized in that the edge (6) of port (27, 45) opening onto the free space is rounded to a radius of 5 - 30 mm.

4. A method according to one of Claims 1 - 3, characterized in that port (27, 45) is formed by placing diaphragm (13) on one, essentially flat, side of cabinet (1) and placing this side close to a wall surface (28), so that at least one port (27) is formed between the edge (6) of the side of the cabinet (1) and the wall surface (28).

5. A method according to one of Claims 1 - 3, characterized in that diaphragm (13) is permanently placed in a construc-

tion forming chamber (9), in the centre of which is the aforesaid port (45) on the side opposite to diaphragm (13).

6. A pillar loudspeaker intended for sound reproduction indoors and outdoors, which pillar loudspeaker includes a cabinet construction supporting a diaphragm (13), at least one operating device (21, 50) for driving the diaphragm, which is operationally a straight, unified, and relatively stiff single component, which is tall vertically and narrow horizontally in such a way that the height H of diaphragm (13) is at least three times, preferably five times greater than its width W, and in which the diaphragm arranged to vibrate mechanically by means of the force of operating device (21, 50) to produce a sound in the free space, the cabinet construction being arranged to prevent acoustic feedback in such a way that the cabinet construction encloses one side of diaphragm (13) within it, the other side having an air connection to the free space, characterized in that the loudspeaker includes a port arrangement (5), comprising at least one port (27, 45) in front of diaphragm (13) in the construction forming chamber (9) and leading away from chamber (9), to allow air to pass from chamber (9) to the free space.

7. A pillar loudspeaker according to Claim 6, characterized in that diaphragm (13) is placed at the side of cabinet (1), which is arranged to be installed with attachment devices (16) at a distance from and facing wall surface (28), at least one port (27) being formed between edge (6) of the side of cabinet (1) and wall surface (28).

8. A pillar loudspeaker according to Claim 6, characterized in that the cabinet construction includes an enclosure construction enclosing diaphragm (13), in which enclosure there is a port (45) on the side opposite diaphragm (13).

9. A pillar loudspeaker according to one of Claims 6 - 8, characterized in that the width d of port (27, 45) is 12 - 30 % on the width W of diaphragm (13).

10. A pillar loudspeaker according to one of Claims 6 - 10, characterized in that the loudspeaker includes several point-like operating devices (21) and that diaphragm (13) has a curved cross-section, to stiffen it.

11. A loudspeaker according to one of Claims 6 - 9, characterized in that the loudspeaker includes one or more high linear operating devices (50).

12. A loudspeaker according to one of Claims 6 - 9, characterized in that diaphragm (13) has a composite material, moulded, or laminated construction, its material being aluminium, kevlar, carbon-fibre, urethane, or wood fibre.

13. A loudspeaker according to Claim 11, characterized in that the voice coil element (55), which moves in the air port (57) of the body of linear operating device (50) and is elongated in its circumferential plane, is attached either directly or indirectly to the base of diaphragm (13).

14. A loudspeaker according to Claim 13, characterized in that the body of linear operating device (50) is a unified component, which forms two high ports between the magnetic poles, with high voice coil (55) being fitted into these ports.

15. A loudspeaker according to Claim 14, characterized the body (56) of high voice coil (55) is made from aluminium.

Fig.1a

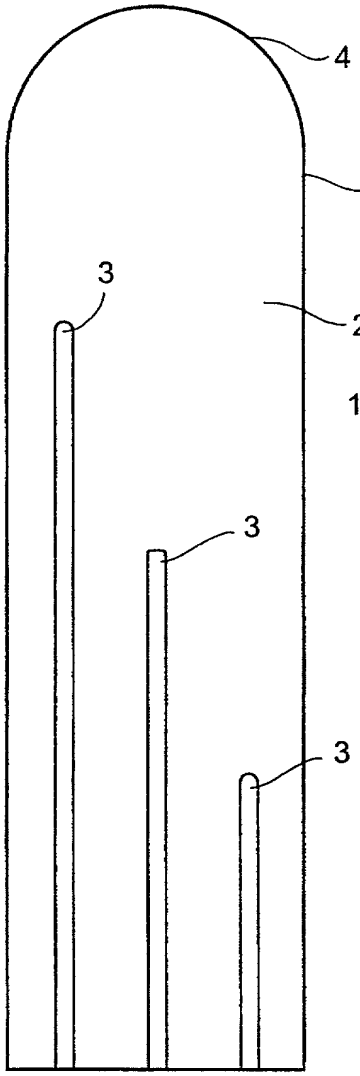


Fig.1b

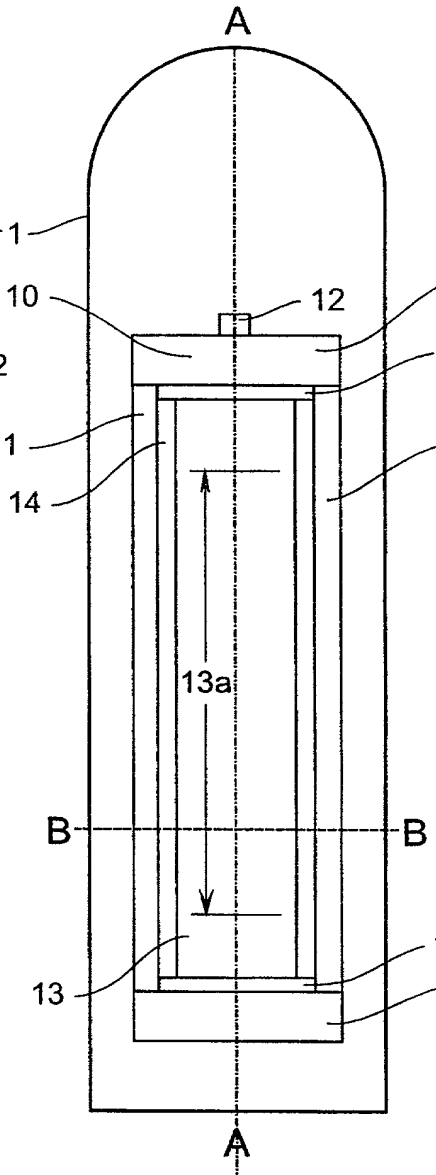


Fig.1c

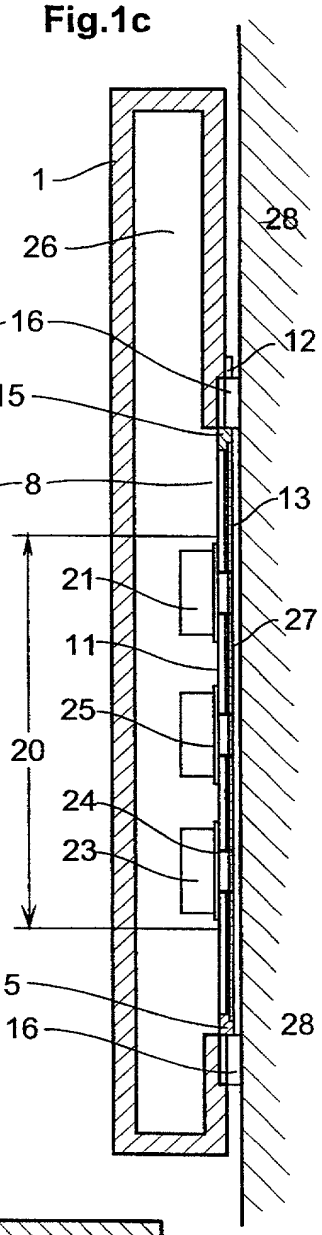


Fig.1d

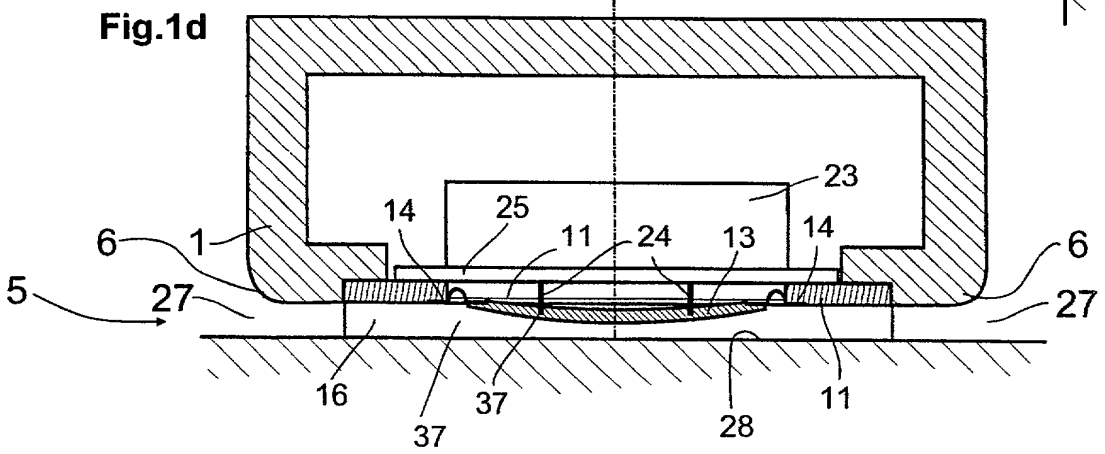


Fig.2a

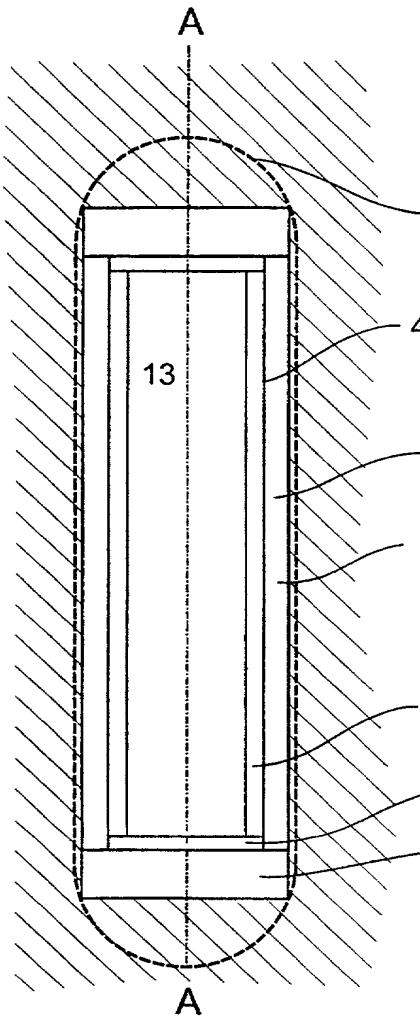


Fig.2b

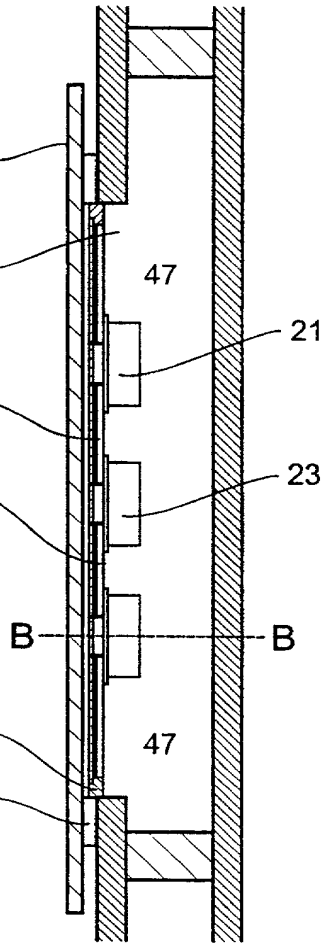


Fig.2c

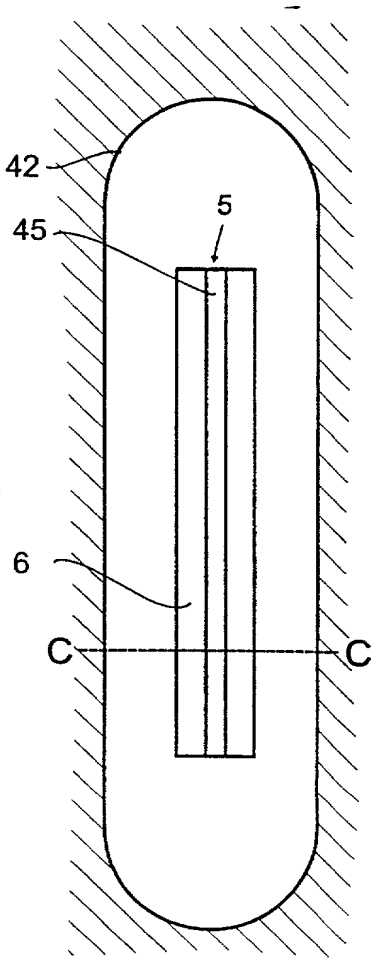


Fig.2d

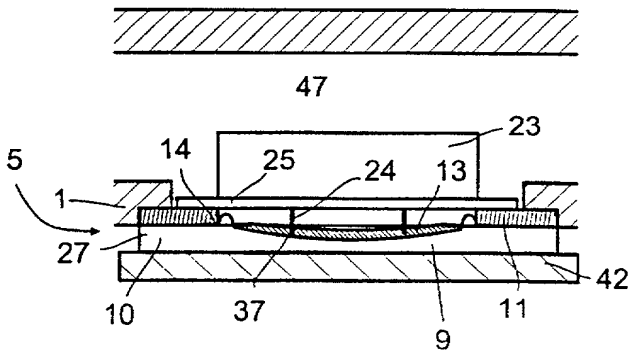


Fig.2e

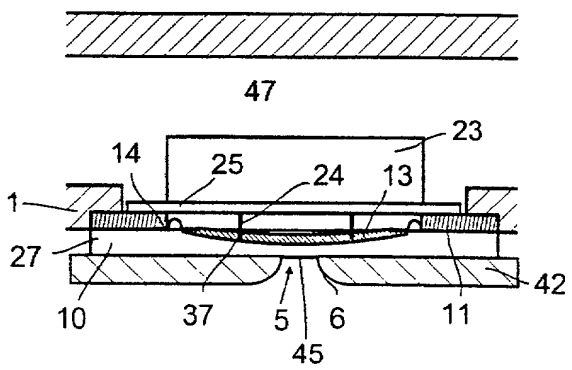


Fig.3a

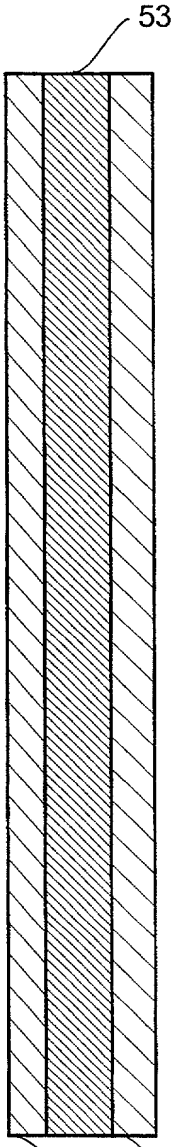


Fig.3b

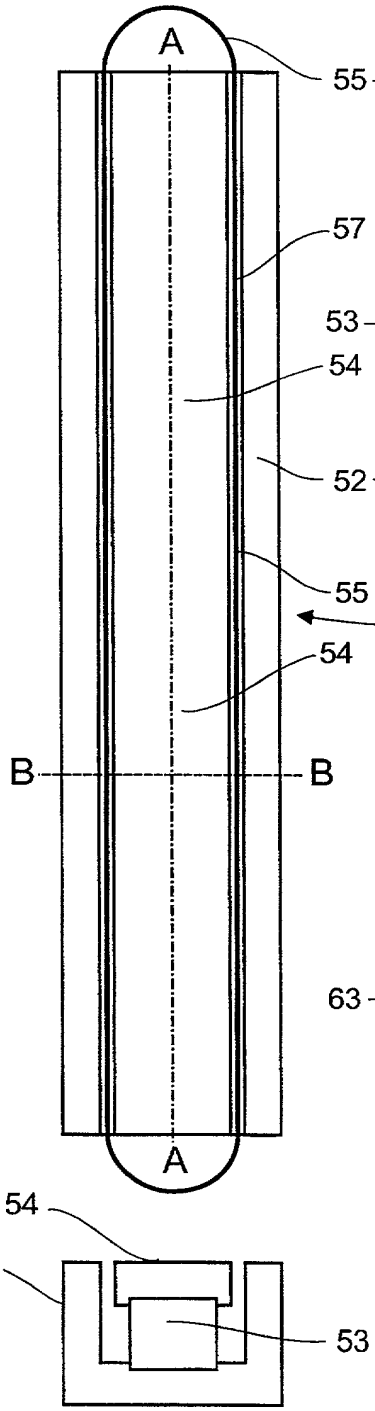


Fig.3c

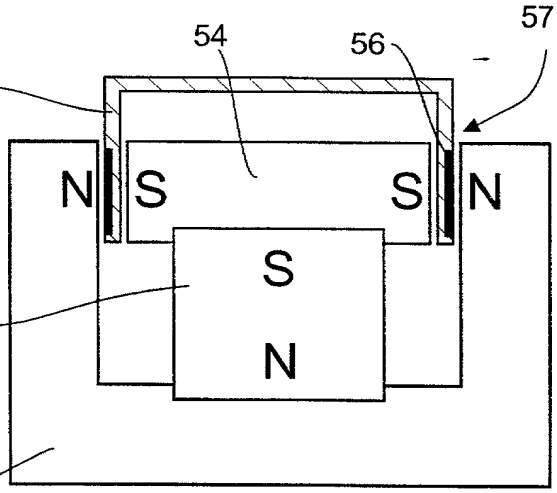


Fig.3d

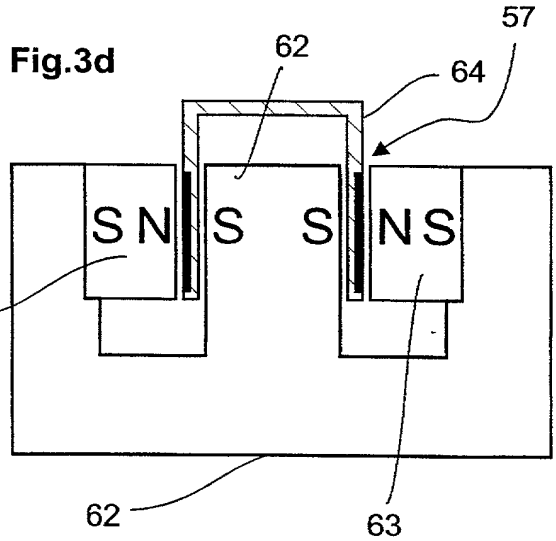
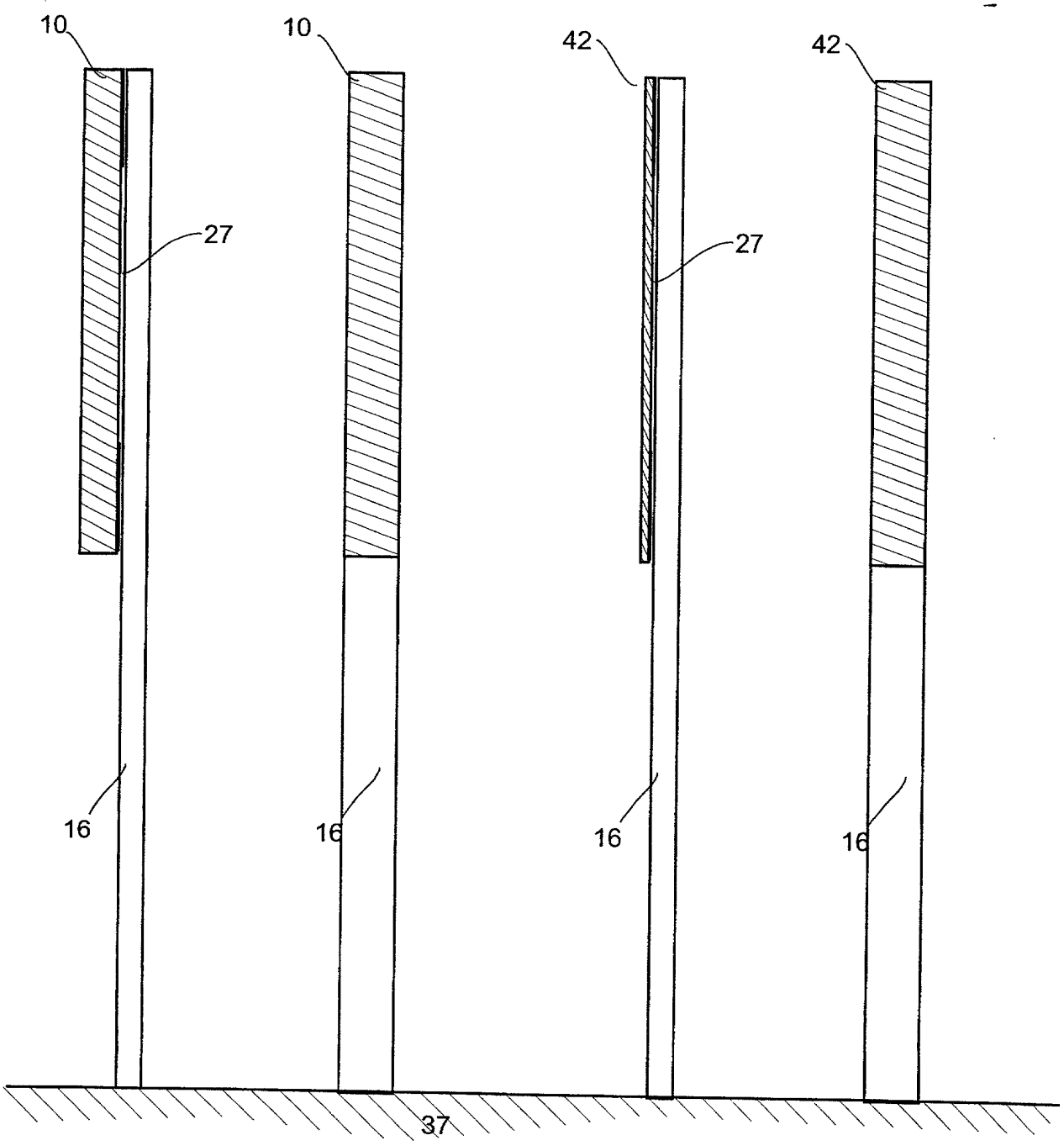


Fig.4a Fig.4b Fig.4c Fig.4d



COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY
(Includes Reference to PCT International Applications)

ATTORNEY'S DOCKET NUMBER
11001.071

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD FOR SOUND REPRODUCTION AND PILLAR LOUDSPEAKER

the specification of which (check only one item below):

☐ is attached hereto.

☐ was filed as United States application

Serial No. _____

on _____,

and was amended

on _____ (if applicable).

☒ was filed as PCT international application

Number PCT/FI99/00767

on 17 September 1999,

and was amended under PCT Article 19

on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate or of any PCT international application(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S) AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. 119:

COUNTRY (if PCT, indicate "PCT")	APPLICATION NUMBER	DATE OF FILING (day, month, year)	PRIORITY CLAIMED UNDER 35 USC 119
Finland	982007	17 September 1998	☒ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO
			☐ YES ☐ NO

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Continued)
(Includes Reference to PCT International Applications)

ATTORNEY'S DOCKET NUMBER
11001.071

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United Sates Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS		STATUS *(CHECK ONE)*		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED

PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO.	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED *(IF ANY)*			
PCT/FI99/00767	17 September 1999			X	

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

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Amanda Conti Duhaime 39,519

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	POST OFFICE ADDRESS	POST OFFICE ADDRESS: Deceased	CITY	STATE & ZIP CODE/COUNTRY
202	FULL NAME OF INVENTOR	FAMILY NAME: Hintsala	FIRST GIVEN NAME: Tapani	SECOND GIVEN NAME
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	POST OFFICE ADDRESS	POST OFFICE ADDRESS	CITY	STATE & ZIP CODE/COUNTRY

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

SIGNATURE OF LEGAL REPRESENTATIVE OF INVENTOR 201	SIGNATURE OF INVENTOR 202	SIGNATURE OF INVENTOR 203
Tuula Noponen		
DATE 26 February 2001	DATE 26 February 2001	DATE

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY (Continued)
(Includes Reference to PCT International Applications)

ATTORNEY'S DOCKET NUMBER
11001.071

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United Sates Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR PCT INTERNATIONAL APPLICATIONS DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. 120:

U.S. APPLICATIONS		STATUS *(CHECK ONE)*		
U.S. APPLICATION NUMBER	U.S. FILING DATE	PATENTED	PENDING	ABANDONED

PCT APPLICATIONS DESIGNATING THE U.S.					
PCT APPLICATION NO.	PCT FILING DATE	U.S. SERIAL NUMBERS ASSIGNED *(IF ANY)*			
PCT/FI99/00767	17 September 1999			X	

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. (List name and registration number)

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LEGAL REP OF INVENTOR	FAMILY NAME Noponen	FIRST GIVEN NAME Sisko	SECOND GIVEN NAME
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POST OFFICE ADDRESS	POST OFFICE ADDRESS Hyttikuja 25	CITY Nivala	STATE & ZIP CODE/COUNTRY Finland 85560

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant or Patentee: Seppo Noponen and Tapani Hintsala

Attorney's Docket No. 11001.071

Serial or Patent No.: _____

Filed or Issued: _____

For: METHOD FOR SOUND REPRODUCTION AND PILLAR LOUDSPEAKER

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) and 1.27(c)) - SMALL BUSINESS CONCERN

I hereby declare that I am

[X] the owner of the small business concern identified below:

[ ] an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN Anturilaakso Oy

ADDRESS OF CONCERN Hyttikuja 25, FIN-85560 Nivala, Finland

I hereby declare that the above-identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled _____

METHOD FOR SOUND REPRODUCTION AND PILLAR LOUDSPEAKER

by inventor(s) Seppo Noponen and Tapani Hintsala

described in

[X] the specification filed herewith

[ ] application serial no. _____, filed _____

[ ] patent no. _____, issued _____

The rights held by the above-identified small business concern are exclusive.

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1 28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING Sisko Noponen

TITLE OF PERSON OTHER THAN OWNER Member of Board

ADDRESS OF PERSON SIGNING Hyttikuja 25, FIN-85560 Nivala, Finland

SIGNATURE Sisko Noponen DATE 26 February2001

PERUKIRJA

Laadittu Nivalassa marraskuun 13. päivänä 2000

Vainaja Noponen Seppo Väinämö

Henkilötunnus 170248-0331
Ammatti toimitusjohtaja
Kuolinpäivä 28.08.2000
Kotipaikka Nivala
Osoite Hyttikuja 25 85560 AINASTALO

Oikeudenomistajat:

1. Leski, Noponen Sisko Virva, 020352-0281, Nivala
Osoite: Hyttikuja 25 85560 AINASTALO

2. Tytär, Noponen Anne Elina, 190987-152V, Nivala
Osoite: Hyttikuja 25 85560 AINASTALO

3. Poika, Noponen Juha Tapani, 081188-1098, Nivala
Osoite: Hyttikuja 25 85560 AINASTALO

4. Tytär, Noponen Ulla Ilona, 280591-212D, Nivala
Osoite: Hyttikuja 25 85560 AINASTALO

Perunkirjoitukseen osalliatujat

Kaikki edellä mainitut oikeudenomistajat sekä uskotut miehet

Perunkirjoituksesta poissaolevat

Kaikki osakkaat olivat läsnä

Perunkirjoituksesta ilmoitettu; miten ja milloin:

Perunkirjoituksesta oli suullisesti sovittu 5.11.2000

Perunkirjoituspaikka

Vainajan asunnossa osoitteessa: Hyttikuja 25 85560 AINASTALO

Asiakirjat Perukirjan perusteiksi esitettiin seuraavat asiakirjat:

1) Sukuselvitys vainajasta
2) Tositteet hautajais- ja muista pesän kuluista
3) Nivalan Järvikylän Osuuspankin asiakkuusilmoitus

Perukirjan osakastiedot vahvistettu Raahen maistraatissa 27.11.2000

Vahvistuspäätös on erillisellä liitteellä. Dnro 157/2000

Translation from Finnish

DEED OF ESTATE INVENTORY

Prepared at Nivala, 13 November 2000

Deceased Noponen Seppo Väinämö

Social security code	170248-0331
Occupation	managing director
Date of death	28 August 2000
Domicile	Nivala
Address	Hyttikuja 25 85560 AINASTALO

Successors:

1. Widow, Noponen Sisko Virva, 020352-0281, Nivala
Address: Hyttikuja 25 85560 AINASTALO

2. Daughter, Noponen Anne Elina, 190987-152V, Nivala
Address: Hyttikuja 25 85560 AINASTALO

3. Son, Noponen Juha Tapani, 081188-1098, Nivala
Address: Hyttikuja 25 85560 AINASTALO

4. Daughter, Noponen Ulla Ilona, 280591-212D, Nivala
Address: Hyttikuja 25 85560 AINASTALO

Participants in the estate inventory

All of the aforementioned successors and executors

Persons absent from the estate inventory

All parties to the estate were present

Notification of estate inventory; how and when:

The estate inventory was orally agreed on 5 November 2000

Place of estate inventory

Residence of the deceased at the address: Hyttikuja 25 85560 AINASTALO

Documents The following documents were presented as the basis of the deed of estate inventory:

1) Extract from the person register of the deceased
2) Receipts of funeral and other expenses of the estate
3) Statement of customer relationship with Nivala Järvikylä Osuuspankki

Details of the parties to the estate confirmed by Raahe Municipal Magistrates Court 27 November 2000
Confirmation decision appended separately Journal No. 157/2000

I hereby certify that the above translation is a true and accurate rendering of the copy of the original Finnish-language document shown to me.

Vantaa, 22 February 2001

Alan Robson
Certified translator

VIRANTEHNYT KIELENKÄÄNTÄJÄ
ALAN ROBSON
CERTIFIED TRANSLATOR

V I R K A T O D I S T U S

Perunkirjoitusta varten

Kirkkoherranvirasto
Vapaudentie 3
85500 NIVALA
☎ (08) 440 025

Paikka, aika ja virasto
Nivala 24.10.2000
Nivalan kirkkoherranvirasto

Sukunimi	Noponen
Etunimet	Seppo Väinämö
Henkilötunnus	170248-0331
Syntymäkotikunta	Nivala
Kansalaisuus	Suomi
Rek.viranomainen	Raahen maistraatti
Seurakunta	Nivala evl
Kotikunta	Nivala
Siviilisääty	Avioliitossa kuollut 28.08.2000
Avioliittotiedot	1. avioliitto, vihkimispäivä 13.09.1986 Puoliso: Sisko Virva Noponen e. Vähäaho ht 020352-0281 Nivala, 1. avioliitto Elää, kansalaisuus Suomi
Lapset	Anne Elina Noponen ht 190987-152V Oulu Elää, kansalaisuus Suomi
	Juha Tapani Noponen ht 081188-1098 Nivala Elää, kansalaisuus Suomi
	Ulla Ilona Noponen ht 280591-212D Nivala Elää, kansalaisuus Suomi
Lisätiedot	Entinen rek.viranomainen KARJASILTA EVL 16.02.1988

V I R K A T O D I S T U S

Perunkirjoitusta varten

Kirkkoherranv…
…
85500 NIVA…
(08) 440 …

Seppo Väinämö muutti Nivalasta 13.12.1984 Ouluun tuomiokirkkoseurakuntaan naimattomana ja Oulusta Karjasillan seurakunnasta 16.2.1988 Nivalaan aviossa.

* *

Yllämainitut tiedot todistetaan oikeiksi seurakunnan kirkonkirjojen perusteella. Tiedot ovat yhdenmukaiset väestötietojärjestelmän tietojen kanssa.

Nimen selvennys VALTTERI OLLI
Virka-asema kappalainen

Vr 37a Lunastus 20.00 mk

Translation from Finnish 1(2)

OFFICIAL CERTIFICATE
For estate inventory

Vicar's Office
Vapaudentie 3
85500 NIVALA
☎ (08) 440 025

Stamp of the Diocese of Oulu

Place, date, and office
Nivala 24 October 2000
Nivala Vicar's Office

Surname	Noponen
Forenames	Seppo Väinämö
Social security number	170248-0331
Citizenship	Finnish
Registrar	Raahe Municipal Magistrate's Court
Congregation	Nivala Ev. Luth.
Municipality of Residence	Nivala
Marital status	Married died 28 August 2000
Marriage information	1st marriage, date of marriage 13 September 1986 Spouse: Sisko Virva Noponen, née Vähäaho soc. sec. 020352-0281 Nivala, 1st marriage Living, Finnish citizen
Children	Anne Elina Noponen soc. sec. 190987-152V Oulu Living, Finnish citizen Juha Tapani Noponen soc. sec. 081188-1098 Nivala Living, Finnish citizen Ulla Ilona Noponen soc. sec. 280591-212D Nivala Living, Finnish citizen

Stamp of the Diocese of Oulu

Additional information	Previous registrar KARJASILTA EV. LUTH. 16 February 1988

VALANTEHNYT KIELENKÄÄNTÄJÄ
ALAN ROBSON
CERTIFIED TRANSLATOR

OFFICIAL CERTIFICATE
For estate inventory

Vicar's Office
Vapaudentie
85500 NIVALA
☎ (08) 440 025

Stamp of the Diocese of Oulu

Seppo Väinämö moved as a batchelor from Nivala to the Oulu Cathedral congregation on 13 December 1984 and while married from the Oulu Karjasilta congregation to Nivala on 16 February 1988.

* * * * * * * * * * * * * * * * *

Stamp of the Diocese of Oulu

The above information is certified as correct on the basis of the church records of the congregation. The information conforms with that in the population register system.

	Signature
Name in Block Letters	VALTTERI OLLI
Official post	Assistant Vicar

Fee FIM 20.00

I hereby certify that the above translation, comprising two (2) pages, is a true and accurate rendering of the copy of the original Finnish-language document shown to me.

Vantaa, 22 February 2001

Alan Robson
Certified translator

VALANTEHNYT KIELENKÄÄNTÄJÄ * ALAN ROBSON * CERTIFIED TRANSLATOR